IN-LB Inch-Pound Units

An ACI Standard

Carbon and Glass Fiber-Reinforced Polymer (FRP) Materials Made by Wet Layup for External Strengthening of Concrete and Masonry Structures—Specification

Reported by ACI Committee 440

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American Concrete Institute
38800 Country Club Drive
Farmington Hills, MI 48331
Phone: +1.248.848.3700
Fax: +1.248.848.3701

www.concrete.org

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Paul Zia

Subcommittee members
David T. Biggs
Luis Ramos

*Contributing authors.
†Task Group Chair.

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This material specification covers the requirements for carbon and glass fiber-reinforced polymer (FRP) systems made by the wet layup process. These systems are externally bonded to concrete or masonry structures and intended for structural strengthening.

Keywords: carbon fiber; fiber-reinforced polymer (FRP); glass fiber; masonry; wet layup.

CONTENTS

ACI 440.8-13 was adopted November 29, 2013 and published January 2014.

1—SCOPE

1.1 This specification describes permitted constituent materials, minimum performance requirements of those constituent materials, and minimum performance requirements for carbon fiber-reinforced polymer (CFRP) and glass fiber-reinforced polymer (GFRP) systems made from those constituent materials using the wet layup process.

1.2 This specification only covers the fabric reinforcement and saturating resin that comprise the FRP system. Primers and putty fillers are excluded.

1.3 This specification applies to FRP laminae consisting of one ply of continuous, unidirectional fabric reinforcement and saturating resin fabricated using the wet layup process. Laminae with fibers in more than one direction that are intended to provide strength in more than one direction are excluded.

1.4 Precured FRP systems are not covered by this specification.

1.5 Hybrid FRP systems consisting of more than one type of fiber are excluded.

1.6 Only FRP systems with epoxy resins are covered by this specification.

1.7 Values in this specification are stated in in.-lb units. A companion specification in SI units is available.

2—DEFINITIONS

2.1 The following definitions govern in this specification. For definitions not given below, refer to "ACI Concrete Terminology," www.concrete.org/Portals/ConcreteTerminology.aspx. For definitions used in but not specific to this specification, refer to ASTM C904.

fabric reinforcement—reinforcing fibers in fabric form.

fiber-reinforced polymer lamina—a single layer of composite material made by combining fabric reinforcement and saturating resin matrix.

fiber-reinforced polymer system—the product fabricated using the wet layup method with the FRP system manufacturer's fiber reinforcement and saturating resin per the FRP system manufacturer's instructions.

mean property—a property value provided by the manufacturer no greater than the mean of results obtained by a specified test method for at least the specified number of specimens. *Discussion*—This value is applicable to FRP chord tensile stiffness, resin properties, and for calculating retention values for durability.

ply—a single layer of fabric reinforcement.

roving—a parallel bundle of continuous yarns, tows, or fibers with little or no twist.

tow—an untwisted bundle of continuous filaments.

ultimate property—a property value provided by the manufacturer no greater than the mean minus three standard deviations of results obtained by a specified test method for at least the specified number of specimens. *Discussion*—This definition is applicable to maximum tensile force.

wet layup—a manufacturing process where dry fabric reinforcement is impregnated on-site with a saturating resin matrix and then cured in-place.

3—REFERENCED STANDARDS

3.1 *ASTM International*

C581-20(2020)—Standard Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass-Fiber-Reinforced Structures Intended for Liquid Service

C904-01(2018)—Standard Terminology Relating to Chemical-Resistant Nonmetallic Materials

D638-22(2022)—Standard Test Method for Tensile Properties of Plastics

D790-17(2017)—Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

D1141-98(2021)—Standard Practice for the Preparation of Substitute Ocean Water

D2247-15(2020)—Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity

D3045-18(2018)—Standard Practice for Heat Aging of Plastics Without Load

D3776/D3776M-20(2020)—Standard Test Methods for Mass Per Unit Area (Weight) of Fabric

D7565/D7565M-10(2017)—Standard Test Method for Determining Tensile Properties of Fiber Reinforced Polymer Matrix Composites Used for Strengthening of Civil Structures

E1640-18(2018)—Standard Test Method for Assignment of the Glass Transition Temperature by Dynamic Mechanical Analysis

G153-13(2021)—Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials.

3.2 *International Code Council—Evaluation Service (ICC-ES)*

AC125—Acceptance Criteria for Concrete and Reinforced and Unreinforced Masonry Strengthening Using Externally Bonded Fiber-Reinforced Polymer (FRP) Composite Systems

4—CLASSIFICIATION

4.1 Fiber-reinforced polymer systems shall be classified according to their fiber reinforcement composition with the first letter of the acronym designating fiber type as follows:

a) CFRP—Carbon fiber-reinforced polymer systems;

b) GFRP—Glass fiber-reinforced polymer systems